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LOUDNESS OF SPEAKING: THE EFFECT OF HEARD STIMULI ON SPOKEN RESPONSES

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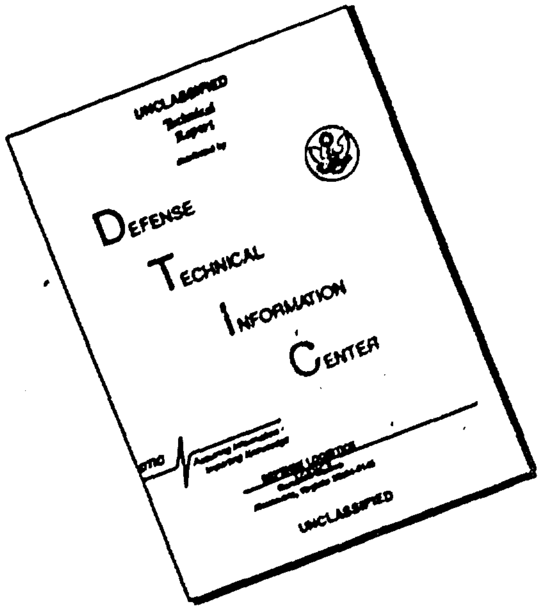

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Loudness of Speaking: The Effect of Heard Stimuli on Spoken Responses

Summary

A series of experiments ~~is in process to~~ determined characteristics of voice that affect the vocal patterns of responding listener-speakers. Summaries of five experiments appear in this report. They treat factors that alter intensity of voice. The data show that in repeating messages that are heard over headsets--except in the instance of very weak signals--the listener responds with greater intensity as he hears more intense signals. It is also demonstrated that vocal loudness is similarly affected when the speaker is answering questions instead of repeating words. Moreover, the subjects in the experiments were unable to maintain a constant intensity when "saying back" words that were heard at different levels of amplification.

Two amounts of noise background introduced into the headsets of the listeners did not significantly differentiate two levels of vocal response. Messages spoken by males and females elicited different intensities, the female being responded to the louder. This observation may be misleading and arise from non-identical intensity levels in the stimulus materials.

Room illumination did not affect the intensity with which the listeners repeated words. (.)

Introduction

One of the attributes of voice that is important in determining the intelligibility of the speaker, irrespective of the speech situation, is intensity of the signal. Training literature for instruction in voice communication in the services acknowledges this fact and advises the student to speak loudly, for example, "just short of shouting" when talking over aircraft radio and interphone. The motivation in these instructions is merely that the speaker make himself understood. The possibility arises, however, that as an additional consequence of the loudness of the speaker's voice the listener may correspondingly reply loudly or softly as the case may be. A series of studies reported here examines the effect of the speaker's signal strength upon the intensity of the listener-speaker's responses. Other experimental variables in-

clude noise background in the listener's headphones, and the sex of the speaker of the stimulus materials. The problem need not be interpreted as having implications only in radio-telephony or with communication over other electrical equipment. Similar psychological factors are doubtless operative in face-to-face communication.

Three of the experiments are closely related in content and procedure and are described together as far as possible as Experiments 1, 2, and 3 (Part I). Two others that are more encompassing studies are treated apart from these although in important aspects they are similar to the first three (Part II).

Part I: Responses to one voice

1. Apparatus and general methodology

The general method for the studies was to present recorded stimuli to experimental subjects individually. The subjects responded orally and the intensities of the responses were measured. The subjects heard the materials through headphones and at controlled levels of intensity.

The stimuli were of two kinds: words and questions. The words were five lists of 12 words from a standard intelligibility test. These were used because list by list they had been equated for intelligibility under conditions of noise and low signal-to-noise ratios. The present studies did not employ noise as a barrier to communication but did have one stimulus condition that approached minimal signal strength for understanding the words. The items were recorded by one male voice and with as nearly equal loudness as the speaker was able to maintain while monitoring his output with a vacuum-tube voltmeter connected to indicate the recording level. Words within a list were spoken at five-second intervals. Between each 12-word list a constant 1000-cycle tone

sounded for 20 seconds and was recorded at a level 20 db below voice peaks. Similarly, this voice read five lists of sentence-questions. At least three peaks in each sentence were as intense as the peak values of the words on the recording of word lists. The interrogatory sentences were selected and adapted from low-level intelligence tests and sentence intelligibility tests. Adaptation was to the extent that the questions could be answered with obvious one-word responses. The principle difference between the two types of stimuli--other than the duration of each item--was that one called for repetitions and the other for the invention of the answer by the subject. Under each circumstance, i.e., words and sentences, the subjects spoke the same word for a given item. (Exceptions in responses to questions were discarded.) Recordings of the stimuli were made with a high fidelity instantaneous recorder operating at 33 r.p.m. Only the outer four inches of a 16-inch recording disc were used.

The equipment for presenting the stimuli and measuring the responses is diagrammed in Figure 1. A calibrated microphone rested eight inches in front of the listener-speaker's lips and was attached through a cable to a General Radio Sound Level Meter, set to operate with <u>slow</u> meter response. The subject sat alone in a room adjacent to the one in which an operator-monitor adjusted the phonograph play-back equipment and read and recorded the meter deflections of the sound level meter. The play-back equipment included a high-fidelity pickup and a 25-watt RCA amplifier connected with the subjects' dynamic, insert-type headphones through a calibrated attenuating pad. The level of playback was set by measuring the output of the amplifier with a Hewl[illegible] vacuum-tube voltmeter during the [illegible] periods when the [illegible] tone was being reproduced. The [illegible] level at the headphones was adjusted with the at-

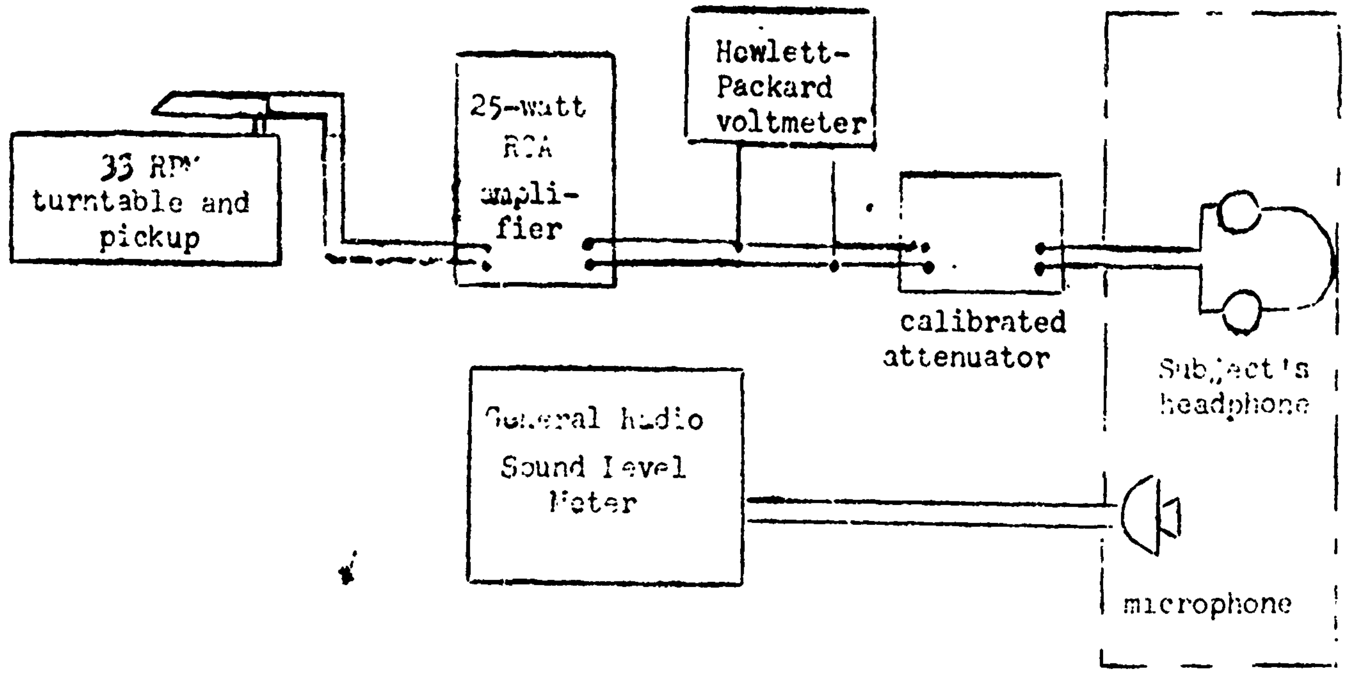


Figure 1. Block diagram of equipment for Experiments 1-4.

tenuating pad. Five settings were used and the amplified signals attenuated by 0, 25, 45, 65, and 85 db. These values were established after five listeners agreed that the levels appeared to divide the range of loudness at the headphones equally. The lowest level was approximately minimal for reception of the stimuli (no error except with voiceless consonants) and the highest level approached pain at the listener's ears.

Each subject was given two sets of instructions, one orally and one visually prior to listening to the recordings. The operator seated him. His head was fixed in position with respect to the microphone by an adjustable headrest. (From subject to subject the operator adjusted the height of the microphone appropriately.) The subject was told:

> Do not touch the headset after it has been adjusted.
> Do not change position.
> Make sure you are comfortable before I leave the room.
> Say the word that you think you hear.
> Talk naturally.
> You will hear further instructions through the headphones.

He faced a poster that read:

> The monitor will inform you when this test is completed.
> Do not move your head or body.
> Keep your eyes open.
> Say the word that you hear.

He heard from the recording:

> You will hear 60 words broken into lists of 12 words each. The lists are separated by a constant tone like this (tone). All of the words in the lists are familiar ones. Immediately upon hearing a word, please say it. We shall now practice. Remember, as soon as you hear a word, repeat it. "Pad"....."Table". That's right. You will now hear the 60 words.

When sentence stimuli were used instead of words, appropriate changes were made in oral and written directions, and the subject heard from the record:

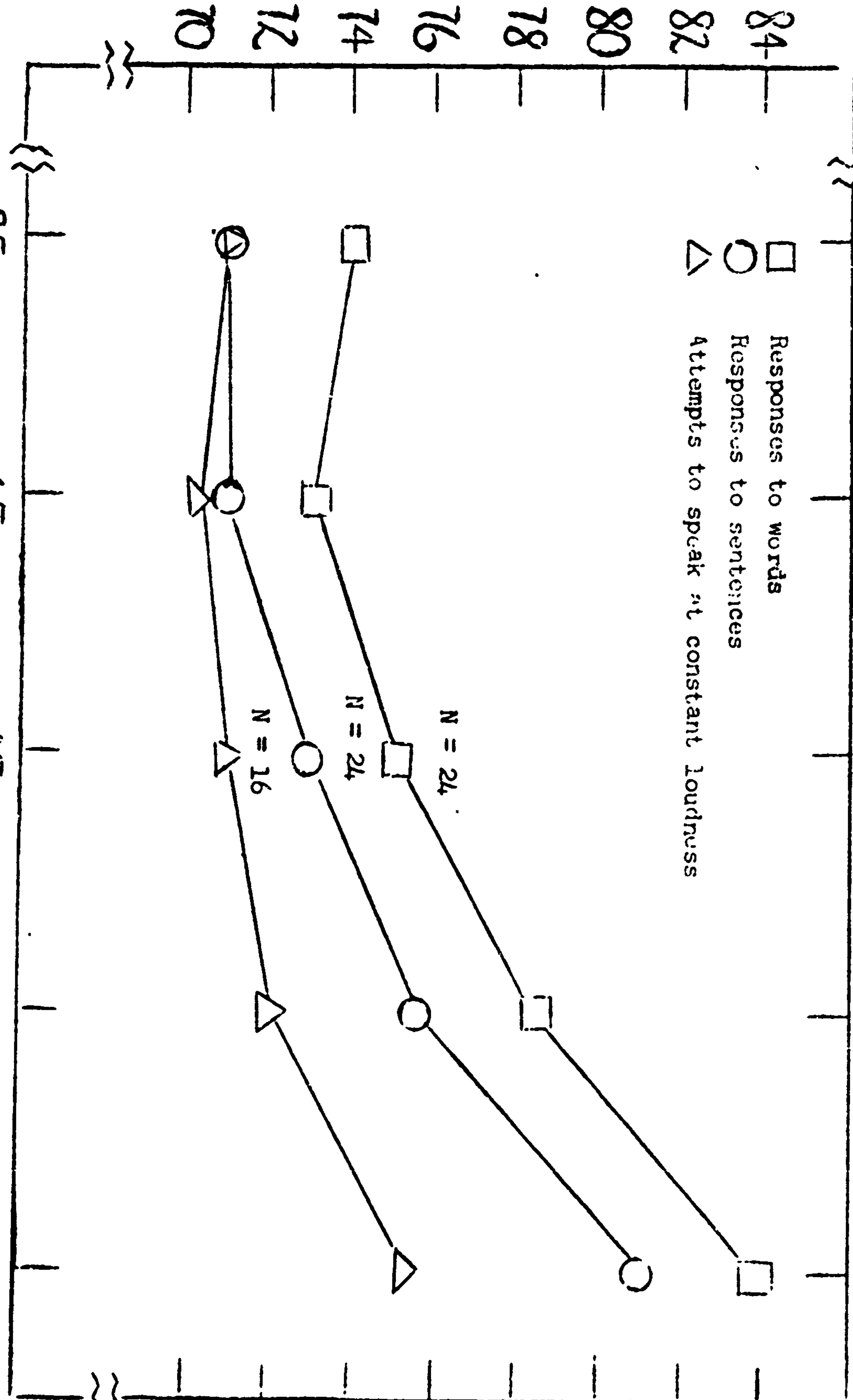
> You will hear 60 sentences broken into five lists of 12 sentences each. Each list is separated from others by a constant tone like this (tone). Each sentence is in the form of a question or request and calls for a simple, one-word response. For example, you might hear "What color is most paper?" You would say white. Or, "Who was the first President of the United States?" You would say Washington. We shall now practice. Remember, as soon as you hear a sentence give the appropriate one-word answer: "The first number after eight is what?" "What does a drinking fountain dispense?" That's right. Remember, make a one-word response to each sentence.

The order of presenting the lists was not varied. The order of presenting conditions was rotated so that each condition was presented first an equal number of times. The subjects were male college students, 25 for Experiments 1-2 and 16 for Experiment 3.

2. Application of the method, and the results of Experiments 1-2

The results of Experiment 1 are summarized in Table I and, graphically, in the top line of Figure 2. In this instance 25 subjects heard

Intensity of responses in db.



Intensity of stimuli in db.

Figure 2. Plots of the intensity of oral responses as a function of the strength of voice signal heard by listener-speakers.

five lists of words, one list at each intensity level. The subject made 12 responses at each level. The median intensity of the 12 responses as indicated by the sound level meter was selected as representative of the condition for each speaker.* Each mean in Table I is computed from 25 medians.

Experiment 1 set the pattern for the series of three studies, both in methods and results. Successive means of intensity levels of responses increased progressively as the stimuli became more intense except in the instance of the two softest levels.

An analysis of variance was made of the data in each experiment and F was highly significant in each of the three studies. This statistic was computed by dividing intensity-conditions variance by the remainder variance. Then, the significance of the differences between the means of responses to successive intensity levels of stimuli was tested. The t's, computed from distributions of differences, increased in magnitude with increases in the intensity of the stimuli. And, importantly, increments in voice intensity in oral responses, presumably induced by the strength of the heard signals, were disproportionately greater as the stimuli became very intense. Successive differences between the four means that were significantly differentiated were respectively 1.92, 3.32, and 5.60 db.

The means of the successive responses were tested for linearity.

* This measure was deemed more typical than the mean, particularly in view of some of the technical limitations of the equipment when used for this purpose. For example, the General Radio Sound Level Meter has a range of 120 db, but with a single setting of the selector knob, only 16 db. Occasionally, for a soft-spoken or loud subject, the knob was adjusted to an inappropriate scale at the outset and the needle either failed to swing or went off scale. Through the use of the median as a representative of the 12 items for each condition extreme deflections of the meter were utilized most reliably, and errors due to technical limitations discarded with minimum loss.

TABLE I

Mean intensity in db (General Radio Sound Level Meter) of oral responses (repetitions) to five levels of intensity of stimuli. Stimulus materials, words. N, subjects, 25.

a. summary of data

Intensity Level of Stimulus	Intensity of response: Mean	S.D.
Condition 1 (Minimal loudness for understanding single words)	74.02	4.67
Condition 2 (Condition 1 plus 20 db)	73.14	3.73
Condition 3 (Condition 2 plus 20 db)	75.06	3.41
Condition 4 (Condition 3 plus 20 db)	78.38	4.40
Condition 5 (Condition 4 plus 25 db)	83.98	4.95

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Intensity conditions (i)	4	2011.01	502.75
Subjects (s)	24	1618.05	
Remainder (ixs)	96	458.99	4.78
Totals	124	4288.05	

F, V_i/V_{ixs} = 502.75/4.78 = 105.18 (1%, 3.51; 4 and 96 d.f.)

c. comparison of means

t's, from distributions of differences

t, condition 1 and condition 2	1.51
t, condition 2 and condition 3	4.04
t, condition 3 and condition 4	6.14
t, condition 4 and condition 5	9.31

(1%, 2.79; 5%, 2.06; 24 d.f.)

The F-analysis for linearity is summarized in Table II. F was highly signicant and thus the probability of linearity was not established. The possibility is self evident in viewing the curves in Figure 2 that different phenomena may occur as subjects respond to stimuli of different intensities. For example, in response to low-level signals the tendency is not to increase response level as signal level is raised. This is a conservative summary in view of the direction of the three curves between conditions 1-2 (-85 and -60 db). Measurements employing more carefully determined threshold values and less gross increments in signal intensity may establish a significant decrement in response level with increases in intensity of signal near the threshold of hearing. Above the 60 db level, the means of responses increased as the intensity of the stimuli was raised. The possibility of a dichotomous population of means prompted a test of linearity for the means of the responses to the four highest intensities. This analysis in summarized in Table IIb. F exceeded the 5% level of confidence, discounting the probability that this stimulus-response regression was linear.

Table III summarizes the intensity of the subjects' one-word responses to the five intensity levels with which they heard the questions (Experiment 2). The means of the responses are plotted as the middle line in Figure 2. Amplification of the signal was the same in reproducing the sentences as in reproducing words, and the same subjects listened and spoke in both experiments. It is difficult to quantify the over-all intensity of the stimulus sentences. It will be remembered, however, that each sentence, had at least three peaks that were as intense as the peak value of the corresponding word item in Experiment 1. Moreover, in recording the sentences precaution had been taken to minimize variations in voice loudness. The respective means of the responses to the suc-

TABLE II

Analysis of variance: test for linearity of regression of mean responses in Experiment 1.

a. five means from Table Ia

Source of variation	d.f.	Sum of squares	Variance
Intensity condition (i)	4	2011.01*	
Due to linearity	1	1653.07	
Departure from linearity (d) (subtract)	3	357.94	119.31

F, V_d/V_{ixs} = 119.31/4.78* = 24.96 (1%, 3.98; 3 and 96 d.f.)

b. four means (2-5) from Table Ia

Source of variation	d.f.	Sum of squares	Variance
Intensity conditions (i)	3	1691.24	
Subjects (s)	24	1354.04	
Remainder (ixs)	72	378.76	5.26
Totals	99	3424.04	

Source of variation	d.f.	Sum of squares	Variance
Intensity conditions (i)	3	1691.24	
Due to linearity	1	1640.73	
Departure from linearity (d) (subtract)	2	50.51	25.255

F, V_d/V_{ixs} = 25.255/5.26 = 4.80 (1%, 4.92; 5%, 3.13; 2 and 72 d.f.)

* From Table 1b.

cessive intensity levels of the sentence-stimuli appear as the second item in each of the following pairs, the first item being the corresponding mean response in Experiment 1 (standard deviations, in parentheses):

	Experiment 1		Experiment 2	
Conditions 1	74.02	(4.67)	71.26	(4.64)
2	73.14	(3.73)	70.94	(4.43)
3	75.06	(3.41)	73.26	(4.29)
4	78.38	(4.40)	75.78	(4.95)
5	83.98	(4.95)	81.14	(5.71)

Obviously, the general pattern of the responses in this study is similar to that in Experiment 1. This is also apparent from a comparison of the two relevant response lines in Figure 2. The difference between the mean responses to the least intense questions (Conditions 1-2) was not significant. (Likewise these conditions were not significantly different in Experiment 1.) All other means of responses to successive stimulus treatments were highly significantly differentiated from each other, exceeding the 1% level of confidence in both experiments.

The comparison of the mean responses in repeating single words and in giving one-word answers to questions is interesting. The means were approximately 2-3 db lower when the subjects invented the answers than when they said-back the words. In order to test the relationships of the data of Experiments 1-2 the results were considered together and a single analysis of variance applied to the arrays of data. A summary of the analysis of variance appears in Table IV. The ratio of the interaction variance for "<u>intensity and conditions</u>" (ixc) and for "<u>intensity, conditions, and subjects</u>" (ixcxs) was not significantly different. This justifies the assumption that the two arrays of data are the "same" in that they represent a single trend (not necessarily zero difference).

TABLE III

Mean intensity in db (General Radio Sound Level Meter) of oral responses (answers to questions) to five levels of intensity of stimuli. Stimulus materials, sentence-questions. N, subjects, 25.

a. summary of data

Intensity Level of Stimulus	Intensity of response Mean	S.D.
Condition 1 (Minimal loudness for understanding single words)	71.26	4.64
Condition 2 (Condition 1 plus 20 db)	70.94	4.43
Condition 3 (Condition 2 plus 20 db)	73.26	4.29
Condition 4 (Condition 3 plus 20 db)	75.78	4.95
Condition 5 (Condition 4 plus 25 db)	81.14	5.71

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Intensity conditions (i)	4	1760.85	440.21
Subjects (s)	24	2434.53	101.44
Remainder (sxi)	96	487.55	5.08
Totals	124	4682.93	

F, V_i/V_{sxi} = 440.21/5.08 = 86.67 (1%, 3.51; 4 and 96 d.f.)

c. comparison of means

t's, from distributions of differences

t, condition 1 and condition 2	.18
t, condition 2 and condition 3	5.27
t, condition 3 and condition 4	5.01
t, condition 4 and condition 5	11.36

(1%, 2.79; 5%, 2.06; 24 d.f.)

There being no over-all interaction for the two components under test in the analysis, intensity and conditions (words-sentences), each was compared with the appropriate first-order interaction variance, respectively "intensity and subjects" and "conditions and subjects." Significance of the main effects, established in Tables I-II, was thus corroborated: F (intensity), 140.25 (1%, 3.51; 4 and 96 d.f.). However, the point of the analysis rested upon testing the hypothesis that no real difference existed between the means of the responses to words and questions. This was tested by the ratio V_c/V_{cxs} with the resulting F, 17.74. This value being highly significant (1%, 7.82), the hypothesis was rejected and the probable independence of the two conditions established. This analysis did not show that each pair of means for the two conditions was dissimilar. The t's were computed (based upon distributions of differences) between corrsponding pairs of word and sentence means at each level of intensity:

	t's
Condition 1	2.82
Condition 2	3.06
Condition 3	3.27
Condition 4	3.81
Condition 5	3.98

Since linearity of the means in Experiment 1 was not established and since the means of the two experiments were found to be the same in trend, a test for linearity of the five conditions in Experiment 2 was not indicated. A test for linearity of regression was made, however, for Conditions 2-5. This, summarized in Table V, resulted in F, 3.45, exceeding significance and making linearity among these conditions improbable.

Clearly, (1) whether repeating words or answering questions, subjects responded with increased intensity to more intense stimuli;

TABLE IV

Analysis of variance of pooled data of Experiments 1-2.

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	4	3704.74	926.19
Condition, i.e. words-sentences (c)	1	372.10	372.10
Subjects	24	3691.70	
ixc	4	9.44	2.36
ixs	96	633.96	6.61
cxs	24	503.20	20.97
ixcxs	96	370.26	3.86
Totals	249	9285.40	

F, V_{ixc}/V_{ixcxs} = 2.36/3.86 = less than unity

F, V_i/V_{ixs} = 926.19/6.61 = 140.25 (1%, 3.51: 4 and 96 d.f.)

F, V_c/V_{cxs} = 372.10/20.97 = 17.74 (1%, 7.82: 1 and 24 d.f.)

(2) the mean speaking performances represented by the upper two lines of Figure 1 were different from each other in intensity at each of the five comparison levels, although (3) the trends of the mean responses to the two conditions, words and sentences, were the same.

In subsequent interviews, subjects were confident that they had not deliberately imitated the loudness of the stimuli when they made their responses in Experiments 1-2. To test whether the factors that led to an increase in intensity of response in keeping with greater intensity of the stimulus were beyond the voluntary control of the subject, a third study, similar in plan to the ones that have been described, was conducted. Sixteen subjects were told:

"Earlier in taking this test you or your fellow students spoke softly when the volume from the record was low, and loudly when it was turned up. We want to know whether it is possible for you to speak with the same loudness irrespective of what you hear. Whatever you hear from the record, do not change your loudness."

Otherwise the study was the same as Experiment 1 and the stimulus materials identical. Of the 16 subjects six had taken part in Experiments 1-2. An analysis of variance was made to find whether the experienced and naive subjects constituted a single population. The relevant F (groups/interaction) appears in Table VII, a footnote to Table VI.

TABLE V

Analysis of variance: test for linearity of regression of mean responses for Conditions 2-5 in Experiment 2.

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	3	1437.64	
Subjects (s)	24	2002.66	
Remainder (ixs)	72	380.86	5.29
Totals	99	3821.16	

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	3	1437.64	
Due to linearity	1	1401.19	
Departure from linearity (d) (subtract)	2	36.45	18.225

F, V_d/V_{ixs} = 18.225/5.290 = 3.45 (1%, 4.92; 5%, 3.13; 2 and 12 d.f.)

and indicates that the experienced and in-experienced subjects constituted a single population, F, 2.57 (5%, 7.71; 1 and 4 d.f.). Table VI summarises the results, and the bottom line of Figure 2 shows them in relation to the results of Experiments 1-2. The mean responses to the five conditions of intensity follow as the second item in each pair. The first item is the corresponding mean from Experiment 1 (standard deviations, in parentheses):

	Experiment 1		Experiment 3	
Condition 1	74.02	(4.67)	71.25	(6.11)
Condition 2	73.14	(3.73)	70.56	(6.39)
Condition 3	75.06	(3.41)	71.31	(5.68)
Condition 4	78.38	(4.40)	72.25	(5.76)
Condition 5	83.98	(4.95)	75.56	(5.49)

In other words, a tendency to talk with greater intensity in keeping with increased intensity of stimuli persisted in spite of the subjects' efforts to talk with a single or constant level. Under these circumstances, the subjects were successful in maintaining constant intensity only when responding to weak or medium-strength signals. Differences between successive means for the first four conditions were not significant. However, differences between Conditions 2-4 were significant and between Conditions 4-5, highly significant.

Also, when the results from the 16 subjects of this experiment are compared with previous group-responses to the same stimuli (words), it is noted that the listener-speakers responded with less intensity when they attempted to talk with a constant loudness. In response to the soft stimuli the "controlled" intensities approximated the "natural" responses to questions--significantly lower than "natural" responses to words. As the intensity levels of the stimuli were increased, the

TABLE VI

Mean intensity of response in db (General Radio Sound Level Meter) to five levels of intensity with each subject attempting to maintain a constant level of loudness throughout. Stimulus materials, words. N, subjects, 16.

a. summary of data

Intensity level of stimulus	Intensity of Response Mean	S.D.
Condition 1 (Minimal loudness for understanding single words)	71.25	6.11
Condition 2 (Condition 1 plus 20 db)	70.56	6.39
Condition 3 (Condition 2 plus 20 db)	71.31	5.68
Condition 4 (Condition 3 plus 20 db)	72.25	5.76
Condition 5 (Condition 4 plus 25 db)	75.56	5.49

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Intensity condition (i)	4	250.88	62.72
Subjects* (s)	15	2504.79	
Remainder (ixs)	60	275.52	4.59
Totals	79	3031.19	

F, V_i/V_{ixs} = 62.72/4.59 = 13.66 (1%, 3.65: 4 and 60 d.f.)

* Six of the subjects served in Experiments 1-2. An analysis was made to find whether the experienced and inexperienced subjects represented a single population.

TABLE VII

Analysis of variance: unequal sub-samples of subjects (experienced and non-experienced).

Source of variation	d.f.	Sum of squares	Variance
Intensity conditions (i)	4	250.88	
Groups (g)	1	20.02	20.02
Interaction (ixg)	4	31.19	7.80
Within subjects	70	2729.10	
Totals	79	3031.19	

F, V_g/V_{ixg} = 20.02/7.80 = 2.57 (5%, 7.71; 1 and 4 d.f.) .

. c. comparison of means

t's, from distributions of differences

t, condition 1 and condition 2		1.06
t, condition 2 and condition 3	.	1.25
t, condition 2 and condition 4	.	2.48
t, condition 3 and condition 4		1.97
t, condition 4 and condition 5		4.54

disparity between the intensities of "controlled" and "natural" responses increased.

An earlier analysis established that the means of Experiments 1-2 were the same in trend although different in values. A similar comparison was made between Experiments 2-3. The results appear in Table VIII. The ratio between the interaction variance, and the error variance [total sums of squares of the two experiments/$(N_{exp.1}+N_{exp.2}-2)(k-1)$] exceeds significance and indicated that the two lower curves in Figure 2 represent different populations of means.

TABLE VIII

Analysis of variance: data of Experiments 2-3 pooled (unequal sub-samples)

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	4	1803.73	
Experiments (e)	1	255.47	
Remainder (ixe)	4	207.99	52.00
Subjects	195	5702.40	
Totals	204	7969.59	

F, V_{ixe}/V_{error^*} = 52.00/6.79 = 7.66
(1%, 3.44: 4 and 156 d.f.)

* See text

3. Summary

The findings of these three studies include the tendency of the subjects to talk with different intensities in keeping with the level of intensity of heard stimulus materials. The trends in this regard were the same whether the materials were words that were to be repeated or questions to be answered by the subjects. Repeated words were spoken more intensely than were answers to questions heard under the same conditions. Finally, it was not possible for the subjects to "say back" words at a single level of intensity when they were heard at different levels.

Part II: Responses to different voices

1. Apparatus and general methodology

Two experiments were conducted largely in the manner of the foregoing ones except that the stimulus words were recorded by six voices, three male and three female.

Experiment 4 was designed to discover whether intensity of oral response varied as a consequence (1) of hearing male and female voices and (2) individuals of the same sex speak the stimuli that were to be repeated; and (3) whether loudness of response was affected by hearing and speaking in a room that was systematically varied among bright-dim-dark degrees of illumination. Thirty male college students served as subjects. The equipment was the same as used in Experiments 1-3 (Figure 1) with the addition of a multiple light-switch.

Experiment 5 introduced as additional variables two levels of noise background into the headsets of the subjects, and continued the comparisons between responses to male and female voices and to two levels of intensity of signal. The study was designed in a factorial manner. Three pairs of experimental variables were counterbalanced in the presentations: high-low signal level (28-9 VU), high-low noise level (5 and 8 VU) and male-

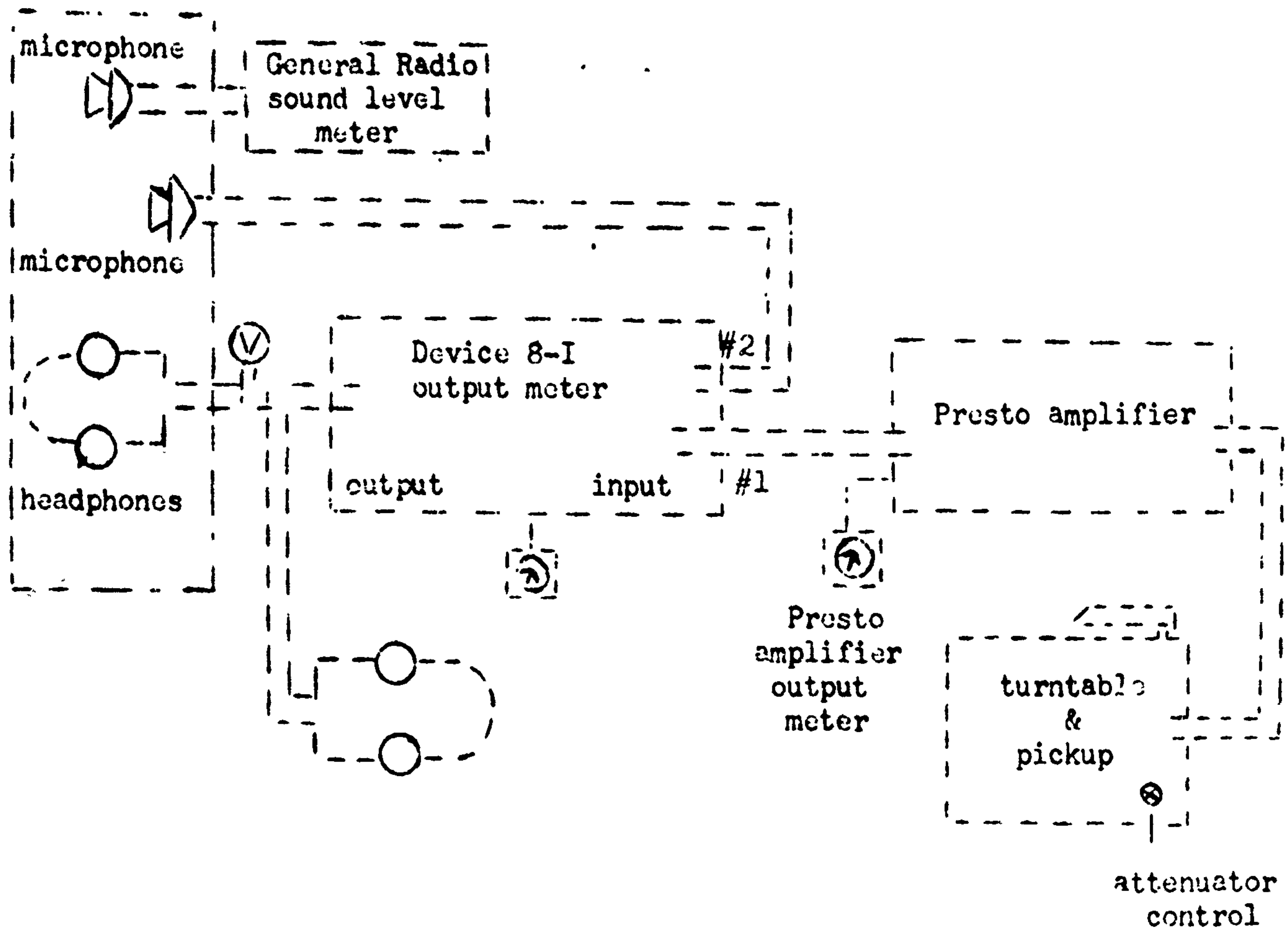


Figure 3. Block diagram of equipment for Experiment 5. Device 8-I is a combination noise generator and intercommunication system with conventional microphone inputs and phone-speaker output taps. Internally generated noise can be fed to output lines.

female voices. Each subject heard eight lists of words. Twenty-four midshipmen acted as subjects.

Figure 3 shows a diagram of the equipment for Experiment 5. As in the experiments described in Part 1, a microphone was placed eight inches in front of the subject's lips; readings were from a General Radio Sound Level Meter; and the median of 12 responses was taken as representative of a condition.*

Again the stimulus materials were lists of words, 12 per list. The readers of the lists monitored their intensity with a voltmeter. Two recordings were made simultaneously, one for use in each experiment.

* A second microphone was placed directly beside the General Radio microphone. This led to a VU meter, and permitted the accumulation of two sets of data, and the checking of one against the other. Both groups of data were analyzed with identical results with respect to significant differences.

Two features of the stimuli became important in the interpretation of the results. The first affects both Experiments 4-5. An analysis of the intensity levels of the stimuli revealed that significant differences occurred among the mean intensities of the six speakers. The intensity values were obtained by connecting a General Radio Output Meter in the subjects' headphone circuit and reading the peak power values (db) of the stimulus words. This check was repeated four times and the mean of the four readings was used for each item. The results of an analysis of variance among the six lists of stimuli appear in Table IX. Obviously the voices were dissimilar (F,11.60; 1%, 3.37). The six voices, however, fell into three pairs (male-female) within which no significant differences occurred, and the means for total male and total female voices were not significantly different.

TABLE IX

Analysis of intensities of six lists of stimuli used in Experiments 4-5 as spoken by six voices, three male and three female.

a. Relative differences in mean intensity among the recorded voices in db. (Order as heard by subjects).

$Male_1$	$Female_1$	$Male_2$	$Female_2$	$Male_3$	$Female_3$
0	-3	-3	-1	+1	+1

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Speakers (s)	5	208.34	41.67
Items (i)	11	93.58	
Remainder (sxi)	55	197.57	3.59
Totals	71	499.487	

F, V_s/V_{sxi} = 41.67/3.59 = 11.60 (1%, 3.37; 5 and 55 d.f.)

Total male-female, t = .47 (5%, 1.96; 70 d.f.)

Male 1-Female 2: t, 1.35 (5%, 2.07; 22 d.f.)

Male 2-Female 1: t, .35 (5%, 2.07; 22 d.f.)

Male 3-Female 3: t, 1.07 (5%, 2.07; 22 d.f.)

Likewise it was possible to pair the six voices to establish comparisons of responses to unequal intensities within male-female pairs. (More intense member of the pair, underlined.)

Male 1-Female 1: t, 3.17 (1%, 2.81: 5%, 2.07; 22 d.f.)

Male 2-Female 3: t, 4.92 (1%, 2.81; 5%, 2.07; 22 d.f.)

Male 3-Female 2: t, 2.70 (1%, 2.81; 5%, 2.07; 22 d.f.)

The second unusual aspect in the presentation of the stimuli occurred in Experiment 5 in which eight conditions were compared from a stimulus recording that contained only six voices and word lists. Thus for each subject the first and last of the four experimental conditions were tested with the same stimulus lists and voices. For the 24 subjects, each pair of male and female voices was included in these comparable presentations eight times and in the orders ab and ba four times each. Both anomalies in stimulus materials led to indicative results without seriously affecting the primary comparisons.

2. Results

The basic results of Experiment 4 appear in Table X. Three facts are apparent: large subject variability, an apparently significant difference between the responses to male and female voices, and the lack of a significant difference corresponding with varied conditions of illumination. Apparently, under the experimental circumstances subjects responded equally loudly in the bright, dim, and dark environments. Neither the interaction variance (lxs) nor the variance for light-conditions equalled in magnitude the triple-interaction variance.

TABLE X

Oral responses (repetitions) to word-lists spoken by six voices and heard in varying conditions of room illumination. N, subjects, 30.

a. Mean intensity (db from General Radio Sound Level Meter)

Stimulus conditions	Male		Female		
	Mean	S.D.	Mean	S.D.	Over-all Mean
Light:					
Bright	77.03	4.61	77.83	4.99	77.43
Half-light	77.17	4.29	77.90	4.50	77.53
Dark	77.10	4.48	77.50	4.43	77.30
Over-all mean	77.10		77.74		77.42

b. Analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Light (l)	2	1.65	.82
Sex (s)	1	18.69	18.69
Subjects (su)	29	3343.91	
lxs	2	1.38	.69
lxsu	58	216.36	3.73
sxsu	29	65.64	2.26
lxsxsu	58	105.29	1.82
Totals	179	3752.91	

F, V_{sxl}/V_{sxlxsu} = .69/1.82 = less than unity.

F, s/sxsu = 18.69/2.26 = 8.25 (1%, 7.60, 1 and 29 d.f.)

The apparent significance of the differences in responding to different sexes, however, is more difficult to assess. The F-ratio,

sxl/lxsxsu was somewhat less than significant. Presumably there was no over-all sex-light interaction. This justified testing the significance of sex against the interaction, sxsu, and the resulting F was highly significant. There remains, however, the problem posed by the fact that the six stimulus voices were significantly dissimilar in intensity. Since Experiments 1-3 established a positive relationship between intensity of response and gross changes in intensity of stimulus, the significant F in this comparison could result from different intensity levels of stimulus voices provided this stimulus-responses relationship is valid for small differences in stimulus levels.

The tentative conclusion is advanced, however, that the subjects did respond disproportionately more intensely to the female than to the male voices apart from reactions to mean intensities of stimuli. An analysis was made of the responses of each subject to the 72 individual stimuli. It will be remembered that the stimulus voices could be paired (male-female) in combinations in which the members were not significantly different in mean intensity, and that each voice was represented by 12 items. For the present analysis, the stimulus items for these voices were paired in such manner that the female voice was the more intense in half of the pairs, i.e., six of the 12. Responses to paired items were checked with the criteria "female more intense" and "female not more intense." Chi-square was computed for each subject and the 30 individual results summated. The results appear in Table XI. First, the total chi-square was highly significant. Second, chi-square for the polled data was highly significant. Third, the interaction or heterogeneity chi-square was non-significant. In keeping with this fact, 26 of the 30 subjects, in a majority of instances, responded more intensely to the "female members" of the paired items. A second observation: the subjects heard the sexes alternately--male, female, etc. Each female voice was responded

to with greater intensity than the preceding male voice: 0, .8; 0, .6; 0, .5 db (only the difference in the first pair, significant). In the stimuli only the second pair of speakers had a comparable relationship, and in the first pair the male voice was significantly more intense than the female. Also in the stimuli, Female 1 was not significantly different in intensity from Male 2. The subjects, however, responded significantly more intensely to the female voice.

The possibility arises that subjects respond more intensely to voices of higher pitch--at least when higher-lower voices are heard alternately.

Earlier experiments of this type have shown that subjects' responses to one male voice vary in intensity as a function of varying the amplification of the stimuli in 20-25 db steps. Similarly in this experiment with the means of the stimuli from three male voices varying 3-4 db, the means of the intensity of the responses varied significantly*:

Stimulus (mean)	t	Response (mean)	t (diff.)
$Male_1$-$Male_2$ = 3 db	3.15 (1%, 2.81)	$Male_1$-$Male_2$ = 1 db	3.32 (1%, 2.76)
$Male_2$-$Male_3$ = 4 db	4.41 (1%, 2.81)	$Male_2$-$Male_3$ = 1.5 db	2.86 (1%, 2.76)
$Male_1$-$Male_3$ = 1 db	1.24 (5%, 2.07)	$Male_1$-$Male_3$ = .4 db	.87 (5%, 2.05)

This relationship was not present between the relative intensity of the stimuli of the female voices and the means of the responses. An analysis of variance testing the hypothesis that a curve of over-all resonse means (intensity) followed the pattern of the stimulus means resulted in a highly significant F, making the hypothesis improbable.

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* The means of intensity of responses to the six voices (in order of presentation) were: 77.5, 78.3, 76.4, 77.0, 77.4, and 77.9 db. An analysis of variance of the responses to the different voices ($V_{speakers}/V_{speakers \times subjects}$) resulted in a significant F, 5.59 (1%, 3.14; 5 and 145 d.f.).

TABLE XI

Summary of the frequency with which male subjects repeated either male or female signals more intensely when the signals had been paired equally between "female more intense" and "female not more intense." Method: Chi-square for individuals and for a[illegible]jects.

	d.f.	chi-square	
Individual chi-squares (added)	30	94.43	(1%, 50.89)
Pooled	1	60.27	(1%, 6.64)
Interaction (subtract)	29	34.16	(5%, 49.59)

Table XII summarizes the results of Experiment 5--the factorial treatment of the effects upon intensity of oral response of sex, noise-background and signal-level variations in the stimulus conditions. Since all of the interaction values (variance) in Table XIIb were small they were combined as shown in Table XIIc with the possibility of using the combination value as the error term. The heterogeneity among subjects, however, indicated by the large within-group variance made it necessary to use subjects variance as the error term in the computations of F. Thus no interaction was significant, and of the main effects, only differences between signal levels resulted in significantly different mean responses. That the two intensity levels of stimuli were responded to differently (the louder the stimulus, the louder the response) is in keeping with the results of Experiments 1-3.

Within the gross limits of this study the signal-to-noise ratio did not significantly affect the intensity of the subjects' speech. This ratio, as well as strength of voice signal, is crucial in determining intelligibility. By definition, as voice signal is increased with back-

ground noise constant, the ratio is improved. Apparently, within a non-critical range, only the strength of the signal, not the amount of background noise, affects significantly the loudness with which a listener responds to a heard stimulus. Relevant to this, although the ratios were markedly different in these comparisons, the signal was always clearly understandable above background noise.

A non-significant tendency is noted. The only interaction variance in Table XIIb of disproprtionate magnitude is nl x sl. Tested against second-order interaction it was not significant. The four means in parentheses in Table XIIa explain this value somewhat. From the means it is observed that responses to low signals were slightly higher when high noise rather than low noise was in the headphones; and to high signals, visa versa.

Finally, sex of the speaker which had significantly differentiated mean responses in Experiment 4 was apparently not significant in the circumstances of this study. (A chi-square test similar to the one performed with the data of Experiment 4 was also inconclusive). However, a separate analysis of variance was made of the data representing sex, subjects, and signal level. The fairly uniform S.D.'s (Table XIIa) made it improbable that subjects variance was unequally distributed among the basic conditions. The separate analysis is inconclusive in this regard.

	d.f.	Variance
Sex (s)	1	10.68
Signal (si)	1	1000.55
Subjects (su)	23	95.33
s x si	1	.92
s x su	23	1.78
si x su	23	7.88
s x si x su	23	10.55

TABLE XII

The effect upon spoken responses of stimuli heard from male and female voices at two levels of loudness and in the presence of two in-circuit noise levels. Stimulus materials, words. N, subjects, 24.

a. mean intensity in db from General Radio Sound Level Meter. (Values in parentheses indicate means of adjacent means. S.D.'s for eight basic observations, in brackets).

	High Noise		Low Noise		Signal	Over-all (Signal)	Combined
High signal							
Male	74.91	[3.76]	75.06	[3.69]	74.99		
	(75.17)		(75.43)			75.30	
Female	75.42	[4.43]	75.80	[3.80]	75.61		
							73.02
Low signal							
Male	70.66	[3.38]	70.48	[3.52]	70.57		
	(70.85)		(70.63)			70.74	
Female	71.04	[3.01]	70.77	[3.93]	70.90		
Noise							
Male	72.79	(72.78)	72.77				
Female	73.23	(73.26)	73.29				
Over-all (noise)	73.01		73.03				
Combined		73.02					

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Main effects:			
Noise levels (nl)	1	.02	.02
Signal levels (sl)	1	1000.55	1000.55
Sex (s)	1	10.68	10.68
First order interaction:			
nl x sl	1	3.03	3.03
nl x s	1	.06	.06
sl x s	1	.93	.93
Second order interaction:			
nl x sl x s	1	.25	.25
Within groups (subjects)	184	2654.08	14.42
Totals	191	3669.60	

c. summary of analysis
(with interactions combined)

Source of variation	d.f.	Sum of squares	Variance
Noise levels (nl)	1	.02	.02
Signal levels (sl)	1	1000.55	1000.55
Sex (s)	1	10.68	10.68
Interaction (i)	4	4.27	1.07
Subjects (su)	184	2654.08	14.42
Totals	191	3669.60	

F, V_{sl}/V_{su}=1000.55/14.42 = 69.39 (1%, 6.78; 1 and 184 d.f.)

From the values shown here there was obviously no significant interaction in the ratio s x si/s x si x su. This permitted testing s/s x su in which instance F, 6.00, was significant (5%, 4.28). One further detail indicates the advisability of conservatism in the interpretation of this result (or the comparable value that would be obtained from the data of Table XIIc through using the combined interaction value as an error term). An anomalous feature in the comparison of the effects of male-female voices upon intensity was in combination with a possible order effect. As explained above the two final conditions for each subject, Conditions 7-8, involved his hearing the same recordings that he heard in Condition 1-2. Voices, orders, and experimental variables were equally represented in these conditions. There was no consistent differences between intensity of responses to male-female voices in Conditions 1-2. However, when the same stimuli occurred in Conditions 7-8, the female voice elicited highly significantly greater mean intensities of response.

3. Summary

Two experiments measured and compared the intensities of oral responses to heard stimuli that represented different voices. In both in-

stances, the subjects tended to respond disproportionately loudly to female voices, although a final generalization about this awaits more exhaustive experimentation. This will have to consider the possibility that heard pitch affects a listener-speaker's loudness in repeating messages. The intensity with which subjects repeated heard words was not affected by the amount of light in the room in which each listener-speaker sat. In conformance with other studies, the subjects responded with more intensity when they heard intense stimuli than when they heard soft ones. Finally, the level of background noise—within the limits investigated—did not affect the speaker's responses to heard stimuli. The possibility remains, of course, that were the background noise and the voice signal of about the same intensity, the voice of the listener-speaker might be affected.

Part III: Interrelations in voice that affect intensity

An earlier report from this laboratory described the effects of heard stimuli upon the rate of spoken responses.* In the three experiments reported there a methodology similar to the ones of this report was employed. Subjects heard stimuli of different rates and repeated the messages naturally. The responses were recorded on a Graphic Power Level recorder and the temporal characteristics of the stimuli and responses were compared as measured. The graphic record contained a vertical dimension proportional to intensity and a linear one representing duration. Furthermore, the 24 subjects read and recorded a list of phrases similar to the ones used as stimulus materials (5-syllable phrases)—this immediately prior to hearing and repeating five lists of messages. A study of three experiments

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* Lightfoot, Charles, Rate of Speaking: I. Relationship between Original and Repeated Phrases, Report 411-1-1 for U.S.N., Special Devices Center.

and the ones summarized in this report give some indications of variables other than the experimental ones that apparently affect vocal intensity. Five are discussed briefly in the following paragraphs. All relate to a study of rate that was designated in the report as one-voice progressive.

1. An effect of order upon intensity

Twenty-five subjects heard five groups of phrases, twelve 5-syllable phrases per list. The order of presentations was rotated so that each list was heard first, second, etc. five times, All of the phrases within a list represented the same duration, five rates among the five lists.

An analysis was made of the intensities of the responses to the first list, second list, etc., the chronological order for each subject. The summary appears in Table XIII. It is apparent from a review of the successive means, Conditions 1-5, that the subjects became progressively less intense from list to list. The analysis of variance indicates that not all of the means are of the same population; and a comparison of the successive conditions reveals two successive pairs of means as well as some non-adjacent ones as significantly differentiated in intensity.

Another experiment provided materials that could be readily analyzed in this manner—Experiment 4 of this report. The effect was not present. Important differences between the two experiments included subjects (midshipmen vs. college students), variety in experimental conditions (one voice with rate as a variable vs. six voices with room illumination changing) and type of meter (Graphic Level recorder vs. General Radio Sound Level Meter). One other instance of a possible order effect was explained in conjunction with Experiment 5. Pairs of male-female voices were responded to alike (in intensity) when the voices were the first two of eight conditions and significantly differently when the same voices were the final pair in the series of conditions, irrespective of order or experi-

TABLE XIII

Intensities in db of oral responses (repetitions) in five successive response conditions (lists of 5-syllable phrases). N, subjects, 25. Experimental variable, rate.

a. mean intensity of response (db from Graphic Level Recorder)

Rates of heard phrases	Mean (db)	S.D.
Condition 1 (fast)	23.1	5.30
Condition 2	22.5	5.03
Condition 3	22.3	5.29
Condition 4	21.6	4.86
Condition 5 (slow)	21.3	5.19

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	4	50.39	12.60
Subjects (s)	24	3153.78	
Remainder (ixs)	96	143.42	1.49
Totals	124	3347.59	

F, V_i/V_{ixs} = 12.60/1.49 = 8.48 (1%, 3.51; 4 and 96 d.f.)

c. comparison of means

t's, distributions of differences

Condition 1 vs. condition 2	2.39
Condition 2 vs. condition 3	1.04
Condition 1 vs. condition 3	2.22
Condition 3 vs. condition 4	2.59
Condition 4 vs. condition 5	.675
Condition 3 vs. condition 5	3.11

(1%, 2.79; 5%, 2.07; 24 d.f.)

mental variable.

No generalization can be drawn from these instances. The importance of including order in counterbalancing stimulus conditions in experiments

such as the ones reported here is indicated. (Note: When the data represented in Table XIII were aligned in keeping with the variables under test, no significant differences occurred in intensity from condition to condition.)

2. Relationship between intensity in reading and in repeating phrases.

In the experiment referred to in the preceding section, the subjects read one list of 12 phrases before hearing and repeating the 60 stimuli of the experiment proper. Read phrases were recorded in the same manner as the others. An analysis was made of the intensities of each subject in reading and repeating. The mean intensities of the 12 subjects who were most intense while reading were compared (t) with the mean intensities of the total population of subjects while repeating heard stimuli. Table XIV includes the means under comparison and the t's between the partial and total group for the five conditions (listening-to and repeating phrases of different rates.)

In four of the five circumstances the members of the selected group were significantly more intense in "saying back" phrases than was the group as a whole.

Under these conditions the intensity of speech while reading was apparently a reliable index for determining a separate population in terms of the intensity with which the subjects repeated phrases.

3. Relationship between rate in reading and intensity in repeating phrases.

Continuing with further measurements, incidental to the experiment referred to immediately above, the 12 fastest of the 25 readers were considered apart from the entire population. Comparisons (t) were made

TABLE XIV

Intensity in db of two groups in repeating lists of 5-syllable phrases. Group 1: twenty-five subjects. Group 2: twelve of the 25 subjects who were more intense than others in reading phrases immediately before experimental conditions (conditions: varying rates of phrases).

a. mean intensity of response (db from graphic level recorder)

Rates of heard phrases	Group 1	S.D.	Group 2	S.D.
Condition 1 (fast)	21.92	5.11	25.28	3.67
Condition 2	22.16	4.80	25.72	3.36
Condition 3	22.03	5.14	25.75	4.47
Condition 4	22.12	5.50	26.11	3.93
Condition 5 (slow)	22.48	5.26	26.30	3.96

b. comparison of means

t, condition 1	1.99
t, condition 2	2.24
t, condition 3	2.09
t, condition 4	2.19
t, condition 5	2.16

(1%, 2.72; 5%, 2.03; 35 d.f.)

between this selected population and the entire group on the basis of the intensity with which each subject repeated the 60 stimulus phrases. Table XV presents the comparisons. Consistently the means of the "fast" population were below the general group means in intensity, but never significantly so. The fact that the value of t generally increased from condition to condition as the subjects heard and repeated slower phrases is provocative of more detailed studies. Interaction between rate and intensity of speech will be investigated.

TABLE XV

Intensity in db of 25 unselected subjects while repeating 5-syllable phrases and 12 of the group who were distinguished through having read one list of phrases prior to the experiment faster than the remaining 13. (Conditions, varying rates of phrases).

a. mean intensity of response (db from graphic level recorder)

Rates of heard phrases	25 subjects	S.D.	12 "fastest"	S.D.
Condition 1 (fast)	21.92	5.11	19.98	4.77
Condition 2	22.16	4.80	19.76	3.92
Condition 3	22.03	5.14	19.36	2.92
Condition 4	22.12	5.50	19.27	4.22
Condition 5 (slow)	22.48	5.26	19.49	3.57

b. comparison of means

t, condition 1	1.08
t, condition 2	1.46
t, condition 3	1.62
t, condition 4	1.54
t, condition 5	1.73

(5%, 2.03; 35 d.f.)

4. Effect of duration of stimulus on intensity of response (repeated phrase).

The possibility that natural rate of oral reading may affect intensity of repetitions of heard stimuli and the fact that rate of saying such repetitions has been found to be affected by the rate of stimulus phrase led to the possibility that intensity of response might be affected by the rate of the stimulus phrase. The same data that were analyzed for the preceding paragraphs were studied from this point of view. The stimuli represented five rates of speaking ranging from approximately 67 to 270

TABLE XVI

Intensity accompanying responses (repetitions) to five conditions of rate. Stimulus materials, 5-syllable phrases. N, subjects, 25.

a. mean intensity of response (db from graphic level recorder)

Rates of heard phrases	Mean (db)	S.D.
Condition 1 (fast)	21.92	5.11
Condition 2	22.16	4.80
Condition 3	22.03	5.14
Condition 4	22.12	5.50
Condition 5 (slow)	22.48	5.26

b. analysis of variance

Source of variation	d.f.	Sum of squares	Variance
Intensity (i)	4	4.46	1.12
Subjects (s)	24	3153.78	131.41
Remainder (r)	96	179.35	1.87
Totals	124	3337.59	

F, V_i/V_r = 1.12/1.87 = less than unity

words per minute. The responses, as shown by the summary of an analysis of variance in Table XVI, were not differentiated by the rate of the stimulus. Intensity variance was less than error variance.

5. Relationship between intensity and rate of response (repeated phrase).

As a final incidental comparison between rate and intensity all of the mean responses for individual subjects to each of the five conditions of rate (rows) were pooled and assigned arbitrarily to five categories

TABLE XVII

Intensity in db accompanying five mean rates of saying (repeating) 5-syllable phrases. Each mean represents one subject saying 12 phrases. N, means, 125. N, subjects, 25.

a. mean intensity (db from graphic level recorder)

Mean phrase duration	N, phrases	Mean (db)	S.D.
Condition 1 (.9 to 1.24 sec.)	25	20.6	2.99
Condition 2 (1.26 to 1.40 sec.)	27	21.0	5.24
Condition 3 (1.44 to 1.64 sec.)	27	20.9	5.79
Condition 4 (1.66 to 1.98 sec.)	23	22.8	4.79
Condition 5 (2.02 to 3.14 sec.)	23	25.9	4.50

b. analysis of variance (unequal sub-samples)

Source of variation	d.f.	Sum of squares	Variance
Total	124	3337.59	
Duration classes (d)	4	473.63	118.41
Individuals (i) (subtract)	120	2863.96	23.87

F, V_d/V_i = 118.41/23.87 = 4.96 (1%, 3.47; 4 and 120 d.f.)

c. comparison of means

t, condition 1 vs. condition 2	.33	(50 d.f.)
t, condition 2 vs. condition 3	.08	(52 d.f.)
t, condition 3 vs. condition 4	1.47	(48 d.f.)
t, condition 4 vs. condition 5	2.14	(44 d.f.)
t, condition 1 vs. condition 5	3.92	(46 d.f.)
t, condition 2 vs. condition 5	3.40	(48 d.f.)
t, condition 3 vs. condition 5	3.20	(46 d.f.)

(1%, approximately 2.57; 5%, approximately 1.95)

(columns) according to their duration. The 125 mean responses fell into

approximately oqual groupings, 23 being the least in a class (column) and 27 the most. The five classes were: (1) .9-1.24 sec., (2) 1.26-1.40 sec., (3) 1.44-1.64 sec., (4) 1.66-1.98 sec., and (5) 2.02-3.14 sec. The mean intensity accompanying each mean duration was computed and given a tabular position identical with its comparable rate-mean. An analysis of variance was made of these data. The results appear in Table XVII. F, 4.96 (from an analysis of variance for unequal columns) was highly significant. As was the case above with respect to another rate-intensity comparison t increased in magnitude with the slowness of rate, Condition 5 being significantly more intense than all others. It should be noted that the distribution of pooled means, five per subject, resulted in the subjects being disproportionately represented in the conditions. The analysis, therefore, does not segregate the relationship between rate and intensity for one voice from that among subjects' voices.

6. Conclusion

The results of five experiments that were designed to find relationships of vocal intensity have been summarized in Parts 1-2. The observations in Part III indicate some tentative statements about interrelationships between vocal rate and intensity. Primarily they present hypotheses to be considered in experimental designs in further investigations. Tentatively it may be assumed that individuals who participate in experiments similar to the ones discussed here may be somewhat biased in vocal intensity in keeping with their rate and loudness in reading from the printed page. Also it is to be expected that vocal rate and intensity are somewhat related and that changes in one affect the other.

Loudness of voice signal is recognized as a key factor in voice communication. Evidently in the normal two-way communication the effect of vocal intensity is a reciprocal one, both aiding in getting a message

across and in eliciting a strong reply. The relative strength of responses elicited by male and female voices is open to further study. Assuming the indications of this report to be true, two possibilities arise: either vocal pitch affects intensity of response or perhaps—under conditions of equated intensity, at least in a "say-back" situation, the male reponds with more intense voice to the female than to the male.